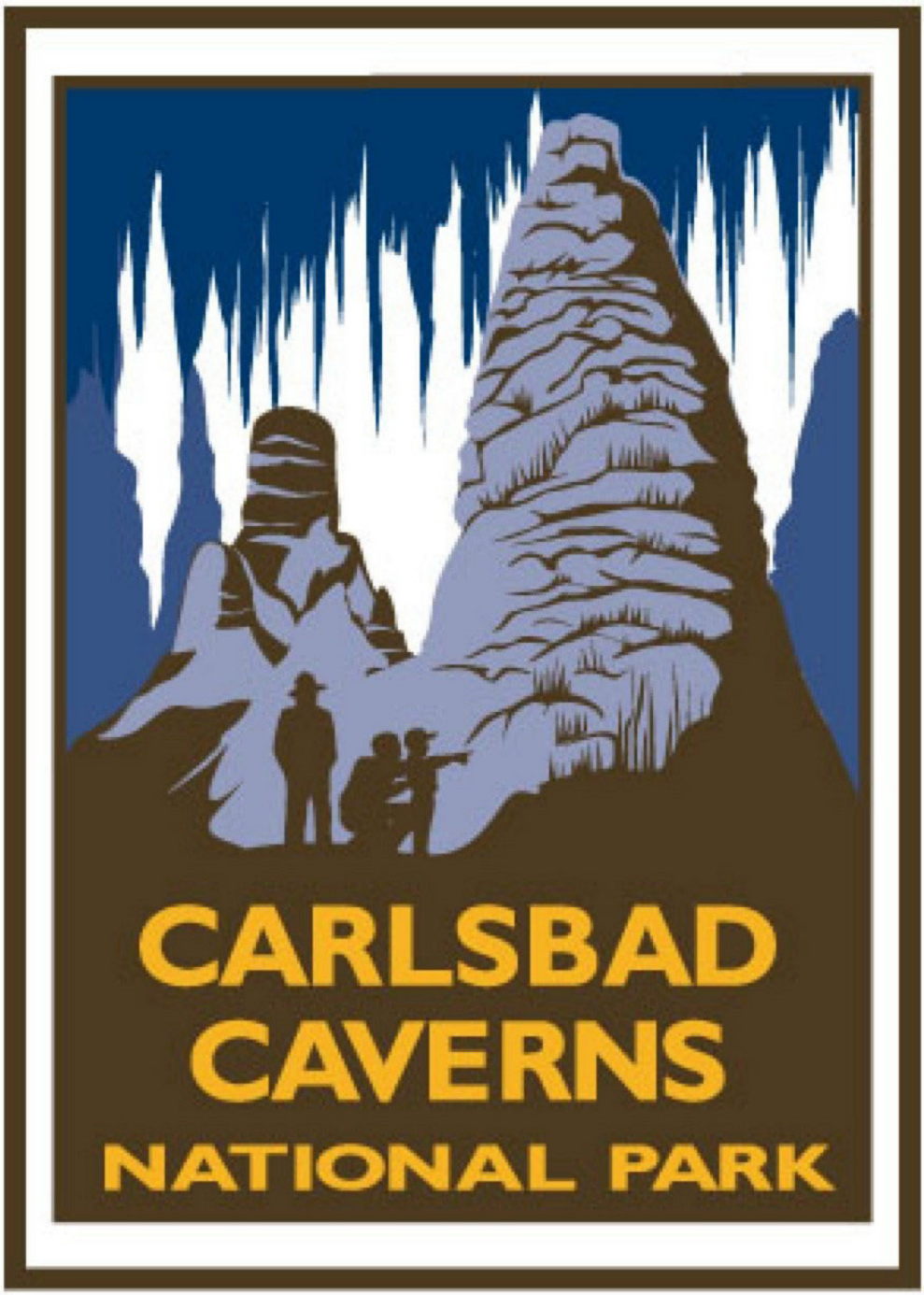
Caves, Canyons, Cactus & Critters

A curriculum and activity guide for Carlsbad Caverns National Park

Middle School Geology



Caves, Canyons, Cactus & Critters
Geology Curriculum

Clams Got Wings!

When I was ten years old, my family took a trip to the mountains. While there, we went for a walk in a meadow at an elevation of around 3000 meters. In that field were the first fossils I ever found. There was something about those fossils that I didn't understand, however. They were fossils of snails and clams in excess of six inches. I was smart enough to know that they were from animals that lived in an ocean environment but I couldn't figure out how they ended up on the top of a mountain in New Mexico, far from any ocean.

A study of the earth's history reveals a planet whose outer layer flexes; some areas rise and fall many times as tectonic plates collide or pull apart. The highest mountain in the world is topped by marine limestone formed in an ocean between Eurasia and India in the distant past. The movement of tectonic plates on the earth's surface creates great stress in the crust. As a result of this stress, the crust is stretched, folded, and broken in many places.

In this unit, students will be introduced to stresses that shape the earth's surface. They will have the opportunity to learn how to identify the various faults and folds geologists study.

You're Stressing Me Out!

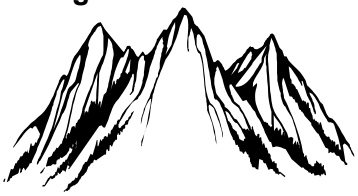
What kinds of stress in the earth cause earthquakes, volcanoes, and build up mountains?

Summary: Students demonstrate the various forms of stress found in the earth's crust.
Duration: One 50-minute class period
Setting: Classroom
Vocabulary: compression, shear, stress, tension
Standards/Benchmarks Addressed: SC2-E1, SC4-E1, SC4-E5, SC5-E2, SC6-E1, SC12-E3

Objectives
Students will:

- describe tension, compression, and shear.

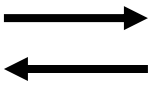
Background



As the lithospheric plates move around on the surface of the earth, a significant amount of *stress* builds up along their boundaries. This stress can be in the form of *compression* where plates are colliding, *tension* where a plate is being pulled apart, or *shear* where plates are sliding sideways past each other.

As plates collide, compression forces the rocks at the boundaries to fold, or, when their elastic limit is reached, to break. These breaks are known as reverse faults. Earthquakes are common in these areas. The Andes Mountains of South America are found along the converging boundary of the South American and Nazca Plates. The mountains and volcanoes of southern Europe are formed along the converging African and Eurasian plates.

Tension is the stress created when a plate begins to split or when plates begin to pull apart. As the rocks along one of these boundaries reach their elastic limits, they begin to break in normal faults. The stretching of rocks and the dropping of faulted blocks along this boundary creates low areas called rift valleys. One of the best-known divergent boundaries is found along the Mid-Atlantic Ridge, where the South American and North American plates are moving away from the African and Eurasian plates. Another example of a rift valley is the Rio Grande rift that runs north to south through central New Mexico. Results of this rifting are the north-south mountain chains bordering the Rio Grande, such as the Sandia Mountains, and much of the historical volcanic activity of central New Mexico.



Shear occurs when two plates slide sideways past each other with very little vertical movement. The fault created by this boundary is called a slip-strike fault. Drag along the boundary, due to friction between the plates, results in additional stress. This stress creates a series of other faults that radiate away from the boundary. Periodic earthquakes serve to relieve this stress. A widely known example of a slip-strike fault is the San Andreas Fault of California.

In this activity, the focus will be on understanding the various forms of stress that build in the crust as the lithospheric plates move. The next lesson, *Achy Breaky Earth,* will explore the faults and folds that occur as a result of stress.

Materials

- clay – enough for each student or group to have three 4"x6"x1/2" layers
- wax paper
- paper to sketch and write notes

Procedure

Warm up: Show the students pictures of an area after an earthquake. Ask the students to describe the destruction they observe. Ask them "What caused this damage?" Once an earthquake has been determined to be the cause, ask, "Would you say that energy was released by this earthquake?" Ask students what they believe the source of that energy to be.

Activity

1. Have students place the three pieces of clay separately on pieces of wax paper.
2. With their hands, have the students slowly begin to push on opposite ends of one of the pieces, causing it to compress. Have them sketch what they observe.
3. Have the students hold the second piece of clay in their hands and begin to slowly pull it apart. Again, have the students sketch what they observe.
4. While holding one side of the last piece of clay flat on the wax paper, have the students begin slowly pushing the other side sideways with their other hand so that one hand slides past the other. Again, have the students sketch what they observe.

Wrap Up: Ask students the following questions:

- What happens to the clay when your hands compress it from opposite directions?
- What happens to the clay when you stretch it?
- What happens to the clay when you push it so that your hands slide past one another?

Discuss the concept of stress in the earth's crust and its possible sources. Describe tension, compression, and shear and relate them to the students' clay samples.

Assessment

Have students:

- define stress and describe its causes in the earth's crust.
- describe tension, compression, and shear and give examples of what types of structures develop in the earth's crust as a result of each.

Extensions

Look at aerial or satellite photos and attempt to find areas on the earth's surface where stress is found. A tectonic map of the earth's surface such as those found in most Earth Science textbooks would be helpful. At each location, have students attempt to determine the type of stress present.

Resources

Feather, Ralph, et al. 1999. *Glencoe Earth Science.* Westerville, OH: Glencoe/McGraw-Hill.

Achy Breaky Earth

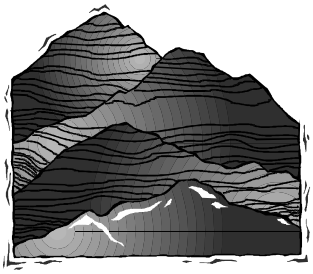
What are the different types of breaks and folds in the Earth called?

Summary: Students describe and prepare models of various faults and folds.
Duration: Two or three 50-minute class periods
Setting: Classroom
Vocabulary: anticline, elastic limit, monocline, normal fault, reverse fault, slip-strike fault, syncline
Standards/Benchmarks Addressed: SC2-E1, SC2-E3, SC4-E1, SC4-E5, SC5-E2, SC6-E1, SC12-E3

Objectives
Students will:

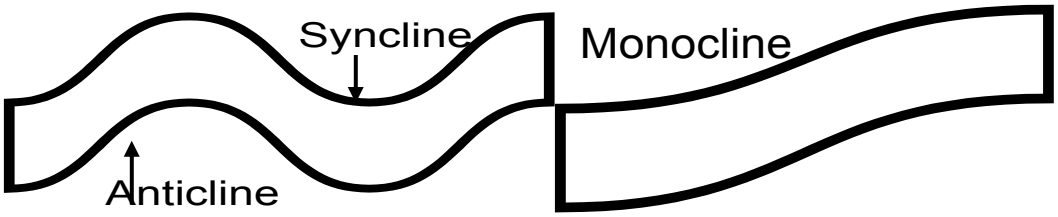
- describe the three primary types of faults (normal, reverse, slip-strike).
- describe the three primary types of folds (syncline, anticline, monocline).
- build clay or cardboard models demonstrating the various faults and folds.

Background

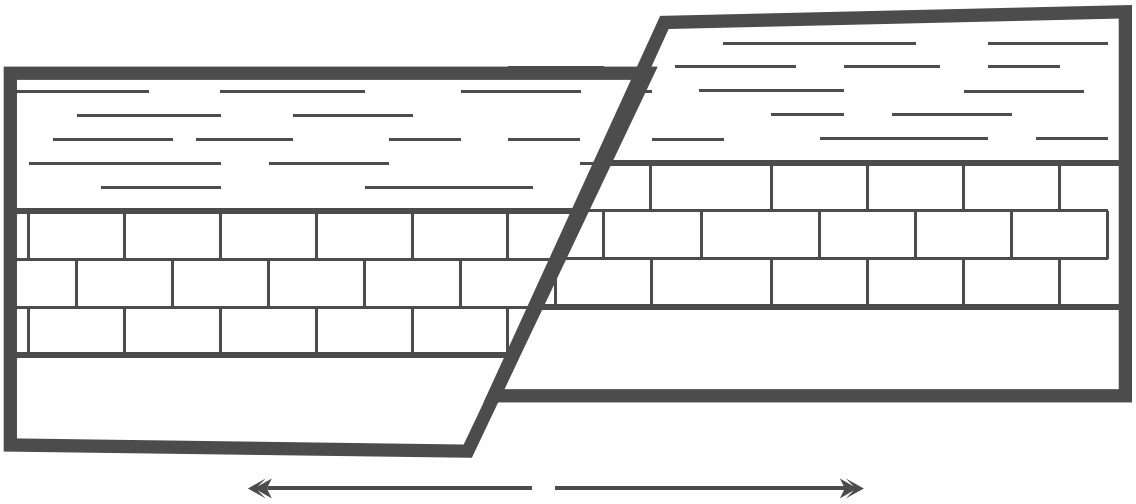


The stresses in the earth that were discussed in the lesson titled *You're stressing me out!* result in faulting and folding at the boundaries of the earth's tectonic plates. In this activity, students will be identifying the various types of faults and folds, as well as building models to represent them.

As stress is applied to an object, that object will begin to give, to fold, or bend. Some objects, such as clay, bend easily. Other objects, such as rocks, required a great deal of heat and pressure before they bend. The folds that form in mountains are a result of compression. An upward fold is called an *anticline* and a downward fold is called a *syncline.* A fold on which there is only a single slope is called a *monocline*.

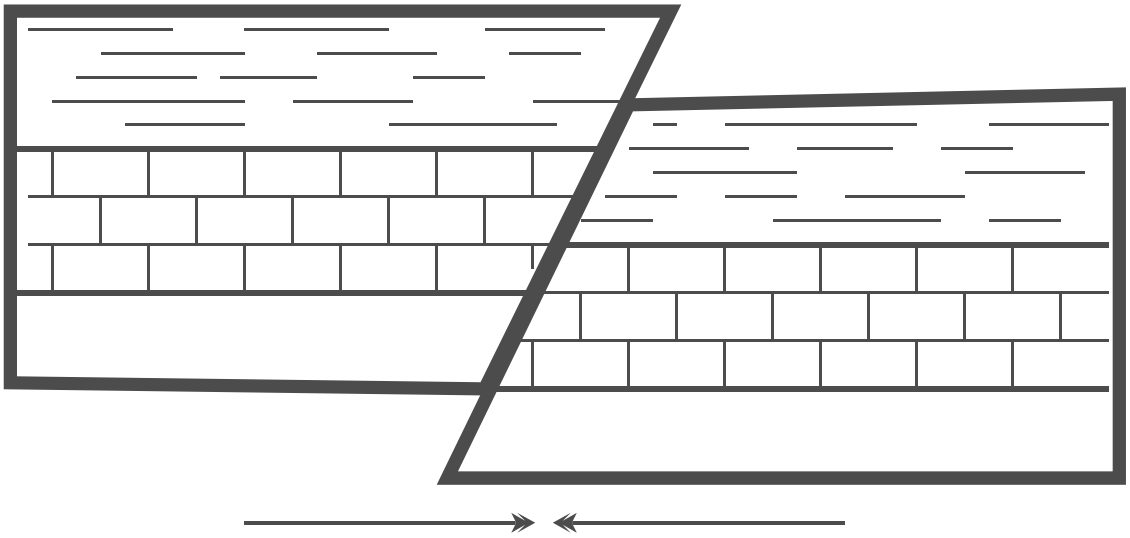


There is a limit to how far things can bend and stretch. This is called the *elastic limit*. Once this point is passed, the object will break, whether it is a rubber band or a rock. If rocks break and movement happens along the break, it is called a fault. A fault caused by compression, in which one block slides up and over the other, is called a *reverse fault*. A fault caused by tension, or stretching, in which one block sinks relative to the other, is called a *normal fault*. A fault caused by shear, in which one block slides sideways along another with very little vertical movement, is called a *slip-strike fault.*



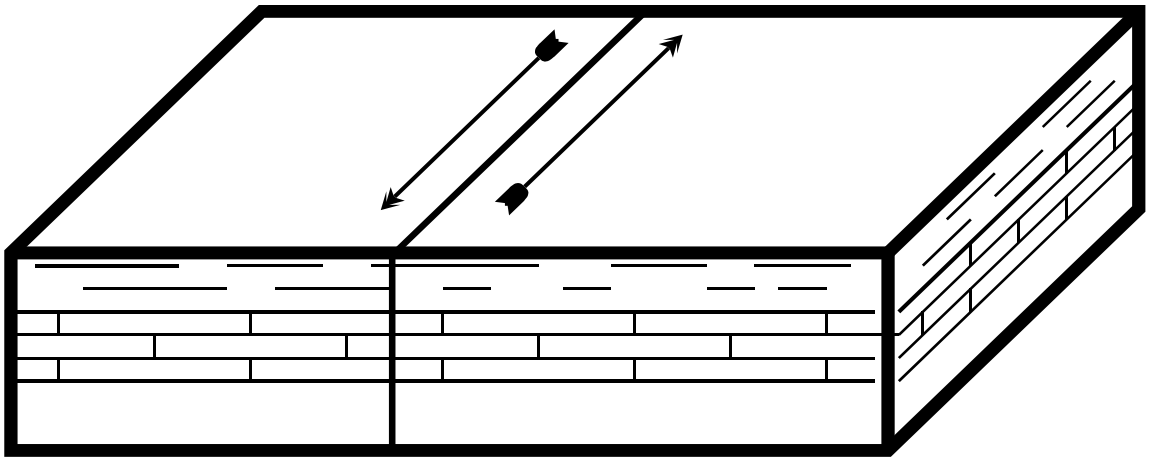
Normal Fault

Normal Faults are formed by tension



Reverse Fault

Reverse Faults are formed by compression



Slip-Strike Fault
Slip-Strike Faults are formed by shear

Faulted mountains are found many places in the world. One of the most spectacular regions is the Himalayas where the Indo-Australian plate is colliding into the Eurasian plate. Compression forces have raised ocean-formed limestone to an elevation of over 8,000 meters in that area. In the western United States, stretching of the North American plate has resulted in many north-south trending fault-block mountain ranges. These mountains form the Basin and Range Province of the southwest. The abrupt edges of the mountain ranges mark a series of normal faults with displacements often in excess of one mile. The Guadalupe Mountains, in which Carlsbad Cavern is located, is an example of a fault-block range. The most spectacular evidence of this is found along the western escarpment near Guadalupe Peak and is clearly visible from Salt Flat, Texas.

On the earth's surface, large scale faulting and folding result in long, linear features when photographed from space. Planetary geologists look for these features as evidence of tectonic activity on other planets. Using these features for clues, they have been able to determine that other planets in our solar system have also experienced tectonic activity. On several planets, they have found evidence of geologic activity that is ongoing. In this lesson, students will be asked to look at maps and try to find surface features on earth that would provide evidence of tectonic activity.

Materials

- textbooks showing diagrams of the varieties of faults and folds
- maps showing surface features such as mountain ranges and river valleys
- wax paper
- clay
- cardboard boxes
- crayons or markers
- scissors
- tape, paste, or glue

Procedure

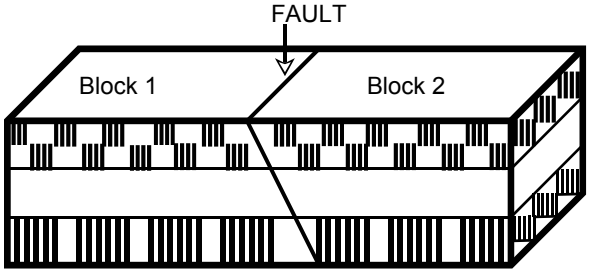
Warm up: Have students study the maps and look for features that have some sort of a regular form or shape (linear, round, or oval, etc.). Discuss with the students what might cause these shapes to form on the earth's surface. The discussion should include plate tectonics and the resulting faults and folding.

Using drawings on overheads or the board, as well as textbook sketches, describe and discuss the various faults and folds with the students.

Activity

Faults

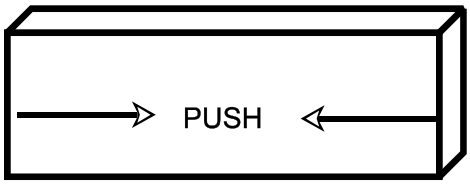
1. Cut and tape, or paste, cardboard boxes to make two "fault blocks" per group, or per student, with one side sloped at about 30^{o} as shown below.



2. Color layers on the boxes that match on both sides. Students can even build little towns (Monopoly house size) on the top of the blocks if they wish.
3. When the blocks are finished, students can slide them along the fault to model reverse, normal, and slip-strike faults.

Folds

1. Layer together two colors of modeling clay in a rectangle about 3"x6"x1". Prepare three blocks in this manner.
2. Place one block of clay over a gap of about four inches between two books. Place a small weight in the middle. Have students sketch what happens. The fold formed will be a syncline.
3. Lay one of the clay blocks on a piece of wax paper. Have the students push the ends of the clay together slowly, as shown below. The fold formed will be an anticline.



4. Place another block of clay on a book with about one to two inches of clay on the book and a weight on the clay over the book to hold it in place. Let the remainder hang over the edge. The fold formed will be a monocline.

Wrap Up: Discuss the various forms of stress that accounted for the various faults and folds. Have students sketch and label each one.

Assessment

Have students:

- name each fault and fold correctly when shown a model or drawing.

- describe the stress or forces in the earth that account for faulting and folding.

Extensions
Obtain photos of other planets or moons. Have the students study the photos for evidence of faults or folds. Have the students describe what this evidence indicates about that planet.

Resources
Feather, Ralph, et al. 1999. *Glencoe Earth Science.* Westerville, OH: Glencoe/McGraw-Hill.

Sprinkel, D.A., Chidsey, T.C., and Anderson, P.B., editors. 2000. *Geology of Utah's Parks and Monuments.* Salt Lake City, UT. Utah Geological Association, publication 28.

VanCleave, Janice. 1991. *Janice VanCleave's Earth Science For Every Kid.* New York, NY, John Wiley & Sons, Inc.